AGRICULTURE

Project Fact Sheet

Improved Chemicals and Plastics from Oilseeds

Benefits

- Reduces petroleum feedstock use
- Introduces a new oilseed crop with a wide variety of industrial uses
- Develops an infrastructure for low-cost feedstock production and processing
- Improves current catalyst technology for conversion of seed oils to value-added products
- Potential 2020 target market is 3.5 billion lb per year
- Projected 2020 total energy savings are 62.5 trillion Btu
- Projected 2020 fossil fuel feedstock displacement is 40.3 trillion Btu

Applications

Castor oil represents an opportunity to expand the industrial applications of oilseeds. The genetic engineering tools may find use in optimizing other oilseeds for industrial products while the development of integrated local systems for crop production, handling, and processing will serve as a model for the introduction of other renewable feedstock operations.

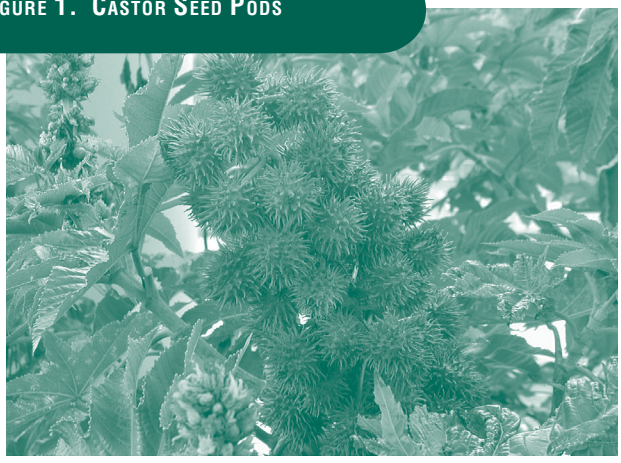
Developing New Oleochemical Feedstocks from the Castor Plant for Plastics, Coatings, and Lubricants

Ever since it was discovered that vegetable oil mixed with ashes could wash away dirt, plant oils have been incorporated into surfactants, detergents, moisturizers, lubricants, and to a limited degree in plasticizers and polymers. High feedstock and processing costs have kept vegetable oils at a disadvantage when compared to petrochemical feedstocks. However, recent work on soybean oil and its potential as a feedstock for lubricants and hydraulic fluids has demonstrated that industrial products comparable or superior to petrochemical products can be cost-competitive. Castor, already a producer of a fatty acid used in many important industrial applications, has been identified as an excellent host plant for the production of specialty oils that can be converted into coatings, foams, adhesives, and engineering thermoplastics.

This project will develop the genetic engineering tools to add to the castor plant the ability to produce the desired specialty fatty acids at high levels. Currently, castor is primarily grown in India where it is harvested by hand. Conventional breeding will be used to improve castor so that it can be grown under a range of field conditions, including marginal dry lands, and be machine harvested. Project collaborator, Castor Oil, Inc., has experience with castor breeding and has been working to reintroduce castor production to the U.S. in Texas by developing varieties suitable to Texas' environmental conditions. Integrated local systems for the production, handling, and processing of castor will also be developed to facilitate the adoption of the crop by domestic farmers.

Separation technologies will be improved and new processing methods, including new catalysts, will be developed to convert the fatty acids produced by the castor plant into useful products and intermediates. Through the product development, researchers will better understand the relationship between the structure of specific fatty acids and functional properties of the materials, and be able to apply this knowledge to fine tuning the feedstock. The final products will be rigorously tested by industrial partners in product applications.

Figure 1. Castor Seed Pods



Project Description

Goal: To develop castor oil as a viable oilseed for use in plastics, lubricants, and coatings.

The project has been divided up into four areas: plant science, production, processing, and utilization. Researchers will use genomics to understand the genetic make up of castor seeds and develop methods to insert the desired fatty-acid producing genes into the castor plant. Promising plants with altered lipid profiles will be selected for genetic crossing trials to evaluate their potential for additional improvements.

The profitability of castor as an industrial crop will be addressed in the area of production. Castor Oil, Inc. will select from their library of castor seed lines the castor varieties that exhibit higher productivity under dry land and semi-irrigated field conditions, crop uniformity, pest and disease resistance, non-dehiscence, and oil quality. The selected varieties will undergo hybrid breeding to further develop the qualities listed above as well as reduced ricin and allergen levels. The castor seed harvesting technologies will be tested and modifications to improve harvesting efficiency will be explored. Efficient milling processes for hulling and cleaning castor seed will be developed as will technologies for the extraction of castor oil from the seed.

The third area of processing will focus on separations, catalyst design, and transesterification of the fatty acids. The quality of the end products is dependent on the quality and uniformity of the fatty acid feedstock. Therefore, it is essential that separation technologies are developed that can fractionate the raw castor seed oil into its different fatty acid portions. The purity limits of the fatty acid feedstock will also be determined and transesterification methods will be optimized for the given feedstock. Several catalyst systems will be developed and evaluated based on turnover numbers, reaction kinetics, catalyst lifetime, stability, support material, and reactor design. Also important will be the potential for catalyst recyclability and the toxicological properties of all by-products and wastes generated.

The products, various polymers and specialty chemicals, will be produced at bench-scale and tested by Dow researchers and by potential customers. Feedback from customers will help the plant scientists further tailor the castor seed to produce fatty acids with the desired material properties. Dow will also perform life cycle analyses on the products to better understand their impact on the environment, agricultural markets, and in the marketplace.

Progress and Milestones

- Plant Science: genetically-engineer castor plants to produce novel fatty acids.
- Production: 1) improve agronomic traits through traditional breeding; 2) test and improve harvesting machinery for use with castor; and 3) develop energy-efficient extraction and milling processes.
- Processing: 1) determine the composition and purity of castor oil and define quality boundaries; 2) develop separation methods for purifying castor oil as well as process intermediates (separation by product streams, etc.); 3) optimize the catalysis process; and 4) develop and characterize catalyst systems.
- Utilization: 1) testing of oilseed-derived chemicals by potential customers in their applications; 2) conduct structure-function modeling studies and use results to further improve the castor plant's oil production; perform a life cycle analysis on oilseed-based chemicals and polymers.

Project Partners

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